

06/20/00  
JC531 U.S. PTO  
3803



VENABLE, BAETJER, HOWARD & CIVILETTI, LLP  
Including professional corporations

1201 New York Avenue, N.W., Suite 1000  
Washington, D.C. 20005-3917  
(202) 962-4800, Fax (202) 962-8300  
www.venable.com

OFFICES IN

WASHINGTON, D.C.  
MARYLAND  
VIRGINIA

jc531 U.S. PTO  
09/597236

06/20/00

June 20, 2000

Attorney Docket: 37174:164287

Assistant Commissioner for Patents  
Washington, D.C. 20231  
Attention: Box PATENT APPLICATION

Sir:

Submitted herewith is a patent application under 37 C.F.R. § 1.53(b) for:

Inventors: Akihiko YAGASAKI

Title: ISOLATION TRANSFORMERS

**This is not a Provisional Application.**

The application includes:

- Specification (28 pages), including claims (1-9) and an Abstract (1 page)
- Formal drawings (6 sheets, Figures 1-12)
- Inventor Declaration and Power of Attorney
- Assignment with Cover Sheet
- Small Entity Declaration - Small Business Concern
- Information Disclosure Statement
- Preliminary Amendment

Priority document, the rights of priority of which are claimed herewith under 35 U.S.C. § 119: Japanese Patent Application No. HEI11(1999)-273755 filed on 28 September 1999 to follow.

Notice of Change of Address

Fee (see formula below) - Check Enclosed:

Basic Filing Fee (large entity = \$690/small entity = \$345)	\$ 345
Total number of claims in excess of 20 (0 x \$18/9)	\$ 0
Number of independent claims in excess of 3 (1 x \$78/39)	\$ 39
Multiple Dependent Claim (\$260/130)	\$ 0
Assignment Recordation Fee (\$40)	<u>\$ 40</u>
<b>TOTAL FEES</b>	<b><u>\$ 424</u></b>

If no check is enclosed or if a greater or lesser fee is required, please charge or credit Deposit Account No. 22-0261 accordingly and notify the undersigned.

The benefit of the filing date of U.S. Provisional Application No. 60/\_\_\_\_\_, filed \_\_\_\_\_ is hereby claimed under 35 U.S.C. § 119(e).

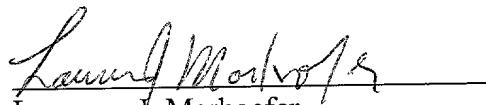
# VENABLE

In view of the above, it is requested that this application be accorded a filing date.

Please address all communications to:

VENABLE  
Post Office Box 34385  
Washington, DC 20043-9998  
Telephone: (202) 962-4800  
Facsimile: (202) 962-8300

Respectfully submitted,

  
Laurence J. Marhoefer  
Registration No. 21,091

DC2-224365

SMALL BUSINESS CONCERN - SMALL ENTITY STATUS

Applicant: Akihiko YAGASAKI

Serial No.: TO BE ASSIGNED

Filed: CONCURRENTLY HEREWITH

For: ISOLATION TRANSFORMERS

## VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) and 1.27(c)) - SMALL BUSINESS CONCERN

I hereby declare that I am

the owner of the small business concern identified below:

an official of the small business concern empowered to act on behalf of the concern identified below:

Name &amp; Address of Concern:

DENKENSEIKI RE.IN. CORP.  
1-41-21, Hachiman-cho Higashi-kurume city  
Tokyo, JAPAN

I hereby declare that the above-identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and 37 CFR 1.9(d) for purposes of paying reduced fees under Sections 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement: (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year; and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties control(s) or has (have) the power to control both.

I hereby declare that the rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled: ISOLATION TRANSFORMERS described in:

the specification filed herewith;

Appln. Ser. No. \_\_\_\_\_ filed \_\_\_\_\_;

Patent No. \_\_\_\_\_, issued \_\_\_\_\_.

If the rights held by the above-identified concern are not exclusive, each individual, concern or organization having rights to the invention is listed below\* and no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 CFR 1.9(d) or by any individual who would not qualify if he/she made the invention under 37 CFR 1.9(c) or a nonprofit organization under 37 CFR 1.9(e).

\*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

Full Name: NONEAddress:  Individual  Small Business Concern  Nonprofit Organization

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of any issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine, or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Name of Person Signing (Please Print): Akihiko YAGASAKITitle of Person Other Than Owner: RepresentativeBusiness Address of Person Signing: 1-41-21, Hachiman-cho, Higashi-kurume city, Tokyo JAPANSignature: Akihiko YagasakiDate: 23 May 2000

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Akihiko Yagasaki

Serial No. to be assigned

Filed: concurrently herewith

For: Isolation Transformers

## PRELIMINARY AMENDMENT

Assistant Commissioner for Patents

Washington, D.C. 20231

Sir:

Prior to examination on the merits, please amend the above-identified application as follows:

In the Claims:

Claims 4, 5, 6 and 7, line 1, delete "2, or 3".

Add the following claims:

10. (New) An isolation transformer of claim 2, characterized by the aforementioned short-circuit rings inserted into every inter-coil-layer space.

11. (New) An isolation transformer of claim 2, characterized by the aforementioned short-circuit rings inserted into selected inter-coil-layer space.

12. (New) An isolation transformer of claim 2, characterized by the aforementioned short-circuit rings made by laminating plastic films.

13. (New) An isolation transformer of claim 2, characterized by the aforementioned short-circuit rings of thickness of  $7 \mu m$  or less.

14. (New) An isolation transformer of claim 3, characterized by the aforementioned short-circuit rings inserted into every inter-coil-layer space.

15. (New) An isolation transformer of claim 3, characterized by the aforementioned short-circuit rings inserted into selected inter-coil-layer space.

16. (New) An isolation transformer of claim 3, characterized by the aforementioned short-circuit rings made by laminating plastic films.

17. (New) An isolation transformer of claim 3, characterized by the aforementioned short-circuit rings of thickness of  $7 \mu m$  or less.

In the Specification:

On the page numbered “1” following page 27, lines 1-3 delete:

“ [DOCUMENT] SUMMARY

[SUMMARY OF THE INVENTION]

[THE ISSUE]”

and substitute – Abstract of the Disclosure --;

line 11, delete “[HOW TO RESOLVE THE ISSUE]”;

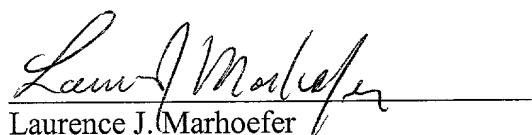
line 27, delete “[THE DRAWING SELECTED] Figure 1”.

## REMARKS

The claims have been amended to remove multiple dependencies. The Abstract of the Disclosure page has been amended to remove inappropriate headings and to insert the proper Abstract of the Disclosure heading.

Respectfully submitted,

Date: 20 Jun '00

  
Laurence J. Marhoefer  
(Registration No. 21,091)  
VENABLE  
P.O. Box 34385  
Washington, D.C. 20043-9998  
Telephone: (202) 962-4800  
Telefax: (202) 962-8300

[DOCUMENT]      SPECIFICATION

[TITLE OF INVENTION]

Isolation Transformers

[CLAIMS]

**[CLAIM 1]** An isolation transformer comprised by a multi-layer, multi-winding primary coil, a multi-layer, multi-winding secondary coil, and a core that forms a magnetic path between the aforementioned primary coil and the aforementioned secondary coil functions as an isolation (noise-cutoff) transformer by changing the coil layers of one or both of the coils formed by winding an insulated, covered, copper-wire to a multi-layer, multi-winding coil, into which a number of short-circuit rings made of conducting films are inserted and layered, and

the surface area of the aforementioned conducting short-circuit rings is made approximately as large as that of the neighboring coil-layers, and their thickness is made approximately identical to or less than the skin-depth of the induced current generated by the skin effect in the high-frequency region, where resonances should be suppressed.

**[CLAIM 2]** An isolation transformer comprised by a multi-layer, multi-winding primary coil, a multi-layer, multi-winding secondary coil, and a core that forms a magnetic path between the aforementioned primary coil and the aforementioned secondary coil, functions as an isolation transformer by changing the coil layers of one or both of the coils formed by winding spirally an insulated, covered, copper-wire to a multi-layer, multi-winding coil, into which a number of short-circuit rings made of conducting films are inserted and layered, and

the planer configuration of the aforementioned conducting short-circuit rings is made approximately identical to that of the neighboring coil-layers, and their thickness is made approximately identical to or less than the skin depth of the induced current generated by the skin effect in the high-frequency region, where resonances should be suppressed.

**【CLAIM 3】** An isolation transformer comprised by a multi-layer, multi-winding primary coil, a multi-layer, multi-winding secondary coil, and a core that forms a magnetic path between the aforementioned primary coil and the aforementioned secondary coil functions as an isolation transformer by changing the coil layers of one or both of the coils formed by winding cylindrically an insulated, covered, copper-wire to a multi-layer, multi-winding coil, into which a number of short-circuit rings made of conducting films are inserted and layered, and

the inner surface area of the aforementioned cylindrical short-circuit rings is made approximately identical to the outer surface of the neighboring coil, and their thickness is made approximately identical to or less than the skin depth of the induced current generated by the skin effect in the high-frequency region, where resonances should be suppressed.

**【CLAIM 4】** An Isolation transformer of claim 1, 2, or 3 characterized by the aforementioned short-circuit ring inserted into every inter-coil-layer space.

**【CLAIM 5】** An Isolation transformer of claim 1, 2, or 3 characterized by the aforementioned short-circuit ring inserted into selected inter-coil-layer space.

**【CLAIM 6】** An Isolation transformer of claim 1, 2, or 3 characterized by the aforementioned short-circuit rings made by laminating plastic films.

**【CLAIM 7】** An Isolation transformer of claim 1, 2, or 3 characterized

by the aforementioned short-circuit rings of thickness of  $7 \mu m$  or less.

**[CLAIM 8]** A transformer comprised by a multi-layer, multi-winding primary coil, a multi-layer, multi-winding secondary coil, and a core that forms a magnetic path between the aforementioned primary coil and the aforementioned secondary coil functions as an isolation transformer by changing the coil layers of one or both of the coils formed by winding an insulated, covered, copper-wire to a multi-layer, multi-winding coil, and each layer of the multi-layer, multi-winding coil is formed by winding an insulated, covered, copper-wire, the surface of which is further covered with a conducting film that is made approximately as thick as or less thicker than the skin depth of the induced current generated by the skin effect in the high-frequency region, where resonances should be suppressed.

**[CLAIM 9]** An Isolation transformer of claim 8 characterized by the aforementioned conducting thin film of thickness of  $7 \mu m$  or less.

#### **[DETEILED DESCRIPTION OF THE INVENTION]**

##### **[0001]**

##### **[TECHNICAL FIELD TO WHICH THE INVENTION BELONGS]**

This invention is related to isolation transformers that suppress high-frequency electromagnetic noise (hereafter called noise) transmitted through power transmission lines and/or signal transmission lines.

##### **[0002]**

##### **[DESCRIPTION OF THE PRIOR ART]**

Micro-computers are being used in various fields such as information, communication, and other industries in addition to daily

life etc. This is due to down-sizing, lower prices, and higher reliability of micro-computers driven by the continuous advancement of integrated circuits. However, integrated circuits are controlled by extremely small electric energy, and therefore, are subject to errors and damages caused by some noise transmitted from external sources. Such events will eventually lead to various inconveniences and/or accidents owing to malfunctioning or stopping of various equipment and devices that contain integrated circuits and of systems using them. Consequently, protection of electronic devices and equipment that contain densely packed and complicated circuits from noise-related troubles have become an urgent issue.

#### 【0003】

For suppression of noise-related troubles isolation transformers of electromagnetic-shield type have been used. The isolation transformers of electromagnetic-shield type have primary- and secondary coils isolated by approximately  $20 \mu m$ -thick aluminum foils. The isolation transformers of electromagnetic-shield type have such attenuation characteristics of normal-mode noise as depicted in Figure 9. Namely, in the frequency range of several hundred Hz to 1 *MHz* the attenuation increases generally mildly with the frequency to  $-50dB$ . In the range from 1*MHz* to 100*MHz* it takes the form of an irregular saw-tooth wave, which is comprised by troughs and crests of various sizes between the maximum of  $-78dB$  and the minimum of  $-24dB$ .

#### 【0004】

The noise attenuation characteristic that occurs in the high-frequency region above a few *MHz*, and takes the form of an irregular saw-tooth wave, which is comprised by troughs and crests of various sizes is caused by stray capacitance appearing uniquely in each

transformer; its origin can be traced to the multi-layer, multi-winding coils having numerous, irregular resonance circuits caused by complicated combinations of infinitesimally different inter-layer and inter-winding distributed capacitance as well as leakage inductances. Components with extremely complicated combinations such as multi-layer, multi-winding coils in transformers thus have random and complicated noise attenuation characteristics; as the crests have extremely low attenuation, this scheme cannot provide highly reliable isolation transformers. In order to improve the reliability of isolation transformers it is necessary to increase the attenuation in the high frequency region exceeding a few *MHz* and to fully decrease each amplitude of the saw-tooth wave comprised by troughs and crests of various sizes, suppressing the crests. As the irregular curves of the attenuation characteristic is unique to each transformer, the ideal suppression mechanism ought to commonly and effectively apply to any transformer. However, it has been impossible for the isolation transformers of electromagnetic-shield type to satisfy this condition.

#### 【0005】

Therefore, this inventor has developed two types of isolation transformers to resolve the aforementioned issue confronting the isolation transformers of electromagnetic-shield type: One of them was made public in the Japanese Patent No.2,645,256, and, as shown in Figure 10, it is an isolation transformer, which is characterized by shielding entirely both primary- and secondary coils by short-circuit rings 4 made of conducting thin films of thickness of  $0.5 \sim 100 \mu m$ .

#### 【0006】

Another is the type published in IEEE (U.S. Institute of Electrical and Electronics Engineers) Transactions on Electromagnetic

Compatibility, Vol.41, No.3, August 1999. As shown in Figure 9, this is an isolation transformer characterized by positioning in the vicinity of, or more specifically, in-between primary- and secondary coils a short-circuit ring 4 made of a conducting thin film, which has a thickness of approximately  $7 \mu m$  or less (hereafter abbreviated as isolation transformer of short-circuit-ring type). As shown in Figure 6 as an example, the core that forms a magnetic path between the primary coil 1 and the secondary coil 2, is manufactured by stacking together pieces of type E core and pieces of type I core of specified dimensions to specified thickness after stamping them out of an isotropic silicon steel sheet of thickness of  $0.5mm$ . Furthermore, the short-circuit ring 4 of conducting thin film is fabricated, as shown in Figure 5 for an example, by cutting a ring, which is approximately as thick as the primary coil 1 and secondary coil 2, out of a rolled aluminum foil of thickness of  $7 \mu m$  and by laminating it to a durable polyester film of thickness of  $50 \mu m$ .

#### 【0007】

This short-circuit ring 4 made of metallic thin film with a large surface area functions as the tertiary coil connected to the primary- and secondary coils, respectively. Through this short -circuit ring 4 of conducting thin film flows the current induced by fundamental wave current flowing through the primary coil, its higher harmonics, and high-frequency noise from external sources. In this case, as the high-frequency components flow essentially at the surface of the conductor only owing to the skin effect, they flow around the short-circuit ring, even if the ring is thin. Therefore, being effectively attenuated by the resistivity of the short-circuit ring, it is hard for the high-frequency components to flow from the primary coil to the secondary coil. At the same time, since the resistivity of the short-circuit ring functions as a

resistance commonly inserted to all of the resonance circuits, which are distributed in the form of a number of infinitesimally small irregularly present resonance circuits due to complex combinations of capacitance and leakage inductances irregularly distributed in the coils, the resistivity of the short-circuit ring has the effect of dramatically reducing the amplitudes of resonances.

#### 【0008】

Meanwhile, the currents induced by the fundamental wave, which are low-frequency components, are reduced in proportion to the cross sectional area of the conducting thin film of the short-circuit ring 4. However, as the short-circuit ring is made of a thin film of thickness of  $7 \mu m$ , its cross section is small albeit its width. Therefore, the induced currents of fundamental-wave component that flows through the short-circuit ring is extremely small. As a consequence, by positioning this short-circuit ring 4 with a wide surface area in the vicinity of the primary- and secondary coils, respectively, an isolation transformer of short-circuit-ring type, which can eliminate or filter high-frequency noise, while keeping the loss of the fundamental-wave negligibly small, is provided.

#### 【0009】

Presented in Figure 11 is an example of attenuation characteristics for the normal-mode noise of the isolation transformer of short-circuit ring type depicted in Figure 9. Namely, in the range from a few hundred *Hz* to  $1MHz$  the attenuation increases generally mildly with the frequency to  $-60dB$ , while in the range from  $1MHz$  to  $100MHz$  it has the form of an irregular saw-tooth wave, which is comprised by crests and troughs of various sizes between the maximum of  $-100dB$  and the minimum of  $-53dB$ . Furthermore, in the range from

100MHz to 300MHz it has the form of an irregular saw-tooth wave, which is comprised by crests and troughs of various sizes between the maximum of -72dB and the minimum of -50dB.

### 【0010】

As is evident in Figure 11, the attenuation characteristic curve of the isolation transformer of short-circuit ring type has a relatively flat portion with steep crests and troughs replaced with crests and troughs of smaller amplitudes. In comparison with isolation transformers of electromagnetic-shield type the isolation transformers of short-circuit-ring type show considerable improvements concerning the attenuation characteristic of normal-mode noise in the high-frequency region over 1MHz. More specifically, as shown in Figure 12, the isolation transformer of electromagnetic-shield type has the lowest attenuation of -24dB, while as shown in Figure 11 the isolation transformer of short-circuit-ring type has that of -53dB, showing an outstanding improvement of 29dB. The same trend exists for the highest points of attenuation, which is -78dB for the isolation transformer of electromagnetic-shield type, while -100dB for the isolation transformer of short-circuit-ring type, showing another outstanding improvement of 22dB.

### 【0011】

Furthermore, in the high-frequency range over 10MHz considerable improvements are observed in the normal-noise characteristic. Namely, as evident in the region encompassed by thick dotted lines, the normal-mode attenuation characteristic in the range from 10MHz to 100MHz of the isolation transformer of the electromagnetic-shield type has the highest point of -78dB and the lowest point of -40dB, while that of the isolation transformer of the

short-circuit-ring type has the highest point of  $-91dB$  and the lowest point of  $-53dB$ , showing considerable improvements of  $13dB$  at both the highest and lowest attenuation points.

#### 【0012】

Though not illustrated, the same trend exists for common-mode noise; isolation transformers of short-circuit-ring type show considerable improvements over isolation transformers of electromagnetic-shield type in the high-frequency region above a few *MHz*.

#### 【0013】

Though inside such components having extremely complicated combinations as multi-layer, multi-winding coils, there exist a number of resonance circuits caused by complicated combinations of infinitesimally different inter-layer and inter-winding distributed capacitance as well as leakage inductances, inside isolation transformers of short-circuit-ring type the effects of stray capacitance due to such resonance circuits are evidently reduced. Moreover, as in addition to increasing the attenuation rates in the high-frequency range above a few *MHz* the amplitudes of the irregular saw-tooth shaped waves with crests and troughs of various sizes were suppressed to the lowest possible level, the reliability of isolation transformers of the short-circuit-ring type has been considerably improved.

#### 【0014】

However, as evidently shown in Figure 11, the suppression of amplitudes of the characteristic curve for the attenuation rate of normal-mode noise with irregular saw-tooth shaped waves with crests and troughs of various sizes in the high-frequency region above a few

*MHz* is not sufficient yet. Therefore, there still remains a question with regard to the reliability of the conventional isolation transformers of short-circuit-ring type with a wide short-circuit ring of conducting thin film covering each surface of primary- and secondary coils and of the isolation transformers of short-circuit-ring type with a wide short-circuit ring of a conducting thin film positioned between and in the vicinity of primary- and secondary coils.

**[0015]**

**[THE ISSUE TO BE RESOLVED BY THE INVENTION]**

The issue to be resolved by the present invention is to provide isolation transformers with high noise attenuation rates as well as high reliability by sufficiently suppressing the amplitudes of noise attenuation characteristic curves, which are irregular, saw-tooth shaped waves with crests and troughs of various sizes, of multi-layer, multi-winding transformers,

**[HOW TO RESOLVE THE ISSUE]**

**[0016]**

An isolation transformer comprised by a multi-layer, multi-winding primary coil, a multi-layer, multi-winding secondary coil, and a core that forms a magnetic path between the aforementioned primary coil and the aforementioned secondary coil, functions as an isolation transformer to resolve the aforementioned issue by changing the coil layers of one or both of the coils formed by winding an insulated, covered, copper-wire to a multi-layer, multi-winding coil, into which a number of short-circuit rings made of conducting films are inserted and layered.

The planer configuration of the aforementioned conducting short-circuit rings is made approximately identical to that of the neighboring

coil-layers, and their thickness is made approximately identical to or less than the skin depth of the induced current generated by the skin effect in the high-frequency region, in which resonances should be suppressed. The aforementioned short-circuit ring is inserted in-between every coil layer or in-between selected coil layers.

As the aforementioned short-circuit ring, a short-circuit ring of conducting thin film or a short-circuit ring of conducting thin film laminated with a plastic film is used.

The aforementioned short-circuit ring has a thickness of  $7 \mu m$  or less.

### 【0017】

Also, an isolation transformer comprised by a multi-layer, multi-winding primary coil, a multi-layer, multi-winding secondary coil, and a core that forms a magnetic path between the aforementioned primary coil and the aforementioned secondary coil functions as an isolation transformer to resolve the aforementioned issue by changing the coil layers of one or both of the coils formed by winding spirally an insulated, covered, copper-wire to a multi-layer, multi-winding coil, into which a number of short-circuit rings made of conducting film are inserted and layered.

The planer configuration of the aforementioned conducting short-circuit rings is made approximately identical to that of the neighboring coil-layers, and its thickness is made approximately identical to or less than the skin depth of the induced current generated by the skin effect in the high-frequency region, in which resonances should be suppressed.

The aforementioned short-circuit rings are inserted into every coil layer or into selected coil layers. As the aforementioned short-circuit rings, short-circuit rings of conducting thin film or short-circuit rings

of conducting thin film laminated with a plastic films are used.

The aforementioned short-circuit rings have a thickness of  $7 \mu m$  or less.

### 【0018】

Moreover, an isolation transformer comprised by a multi-layer, multi-winding primary coil, a multi-layer, multi-winding secondary coil, and a core that forms a magnetic path between the aforementioned primary coil and the aforementioned secondary coil functions as an isolation transformer to resolve the aforementioned issue by changing the coil layers of one or both of the coils formed by winding cylindrically an insulated, covered, copper-wire to a multi-layer, multi-winding coil, into which a number of short-circuit rings made of conducting film are inserted and layered.

Furthermore, the inner surface of the aforementioned cylindrical short-circuit rings is made approximately identical to the outer surface of the neighboring coil, and their thickness is made approximately identical to or less than the skin depth of the induced current generated by the skin effect in the high-frequency region, in which resonances should be suppressed.

The aforementioned short-circuit rings are inserted in-between every coil layer or in-between selected coil layers.

As the aforementioned short-circuit rings, short-circuit rings of conducting thin film or short-circuit rings of conducting thin films laminated with plastic films are used. The aforementioned short-circuit rings have a thickness of  $7 \mu m$  or less.

### 【0019】

Furthermore, an isolation transformer comprised by a multi-layer, multi-winding primary coil, a multi-layer, multi-winding secondary

coil, and a core that forms a magnetic path between the aforementioned primary coil and the aforementioned secondary coil functions as an isolation transformer by changing the coil layers of one or both of the coils formed by winding an insulated, covered, copper-wire to a multi-layer, multi-winding coil.

Each layer of the multi-layer, multi-winding coils are formed by winding an insulated, covered, copper-wire, the surface of which is further covered with a conducting film that is made approximately as thick as or less thicker than the skin depth of the induced current generated by the skin effect in the high-frequency region, where resonances should be suppressed.

The aforementioned conducting thin films have a thickness of  $7 \mu m$  or less.

## 【0020】

### 【DESCRIPTION OF THE PREFERRED EMBODIMENTS】

Figure 1 depicts a cross section of an isolation transformer of the short-circuit-ring type, which is the first embodiment of the present invention with its bobbin and core omitted and with much reduced numbers of windings and layers for easier comprehension. Figure 2 depicts a magnified part of Figure 1. The primary coil is a ring-type coil, in which an insulated, covered, copper-wire 5 was wound with many (N1) layers and many (M1) windings. Likewise, the secondary coil is also a ring-type coil, in which an insulated, covered, copper-wire 5 was wound with many (N2) layers and many (M2) windings. The insulated, covered, copper-wire 5 is a general one with an insulated cover 5b such as enamel placed over a copper-wire 5a. For example, a transformer with output 10VA for fundamental wave with voltage 22V has 156 as M1, 166 as M2 as well as 13 as N1 and 14 as N2, respectively.

### 【0021】

As shown in Figure 6, the core that forms a magnetic path between the primary coil 1 and the secondary coil 2, is a general one manufactured by stacking together of pieces of type E core and pieces of type I core of specified dimensions to specified thickness after stamping them out of an isotropic silicon steel sheet of thickness of 0.5mm.

### 【0022】

The short-circuit ring 4 of conducting thin film is fabricated, as shown in Figure 5 as an example, by cutting a ring, which is approximately as thick as the primary coil 1 and the secondary coil 2, out of a rolled aluminum foil of thickness of  $7\mu m$  and by laminating it to a durable polyester film of thickness of  $50\mu m$ . This is fundamentally the same as the ones used in existing isolation transformers of short-circuit-ring type shown in Figure 9.

### 【0023】

In the first embodiment a short-circuit ring 4 of conducting thin film is positioned between each coil layer of each coil. Namely, in the primary coil 10, which is comprised by five coil layers 11, 12, 13, 14, and 15, a short-circuit ring 4 of conducting thin film is inserted in-between all the coil layers, and a short-circuit ring 4 of conducting thin film is positioned under the coil layer 11 as well as on the coil layer 15. Likewise, in the secondary coil 20, which is comprised by five coil layers 21, 22, 23, 24, and 25, a short-circuit ring 4 of conducting thin film is inserted in-between all the coil layers, and a short-circuit ring 4 of conducting thin film is positioned under the coil layer 21 as well as on the coil layer 25. Therefore, in the isolation transformer of the first

embodiment there are in all twelve short-circuit rings 4 of conducting thin film used with six of them positioned in the primary coil and six others in the secondary coil.

#### 【0024】

The method to position a short-circuit ring 4 made of a planer, ring-shaped, conducting thin film into the space between coil layers in an isolation transformer of short-circuit-ring type shown in Figure 4 is as follows: Namely, at the bottom of a bobbin, which is not illustrated, the first short-circuit ring 4 made of a planer, ring-shaped, conducting thin film is placed, and an insulated, covered copper-wire 5 is wound once by a winding machine to make a layer, forming a planer spiral, which is not illustrated. Then at the coil layer 11, which was just wound, the second short-circuit ring 4 made of a planer, ring-shaped, conducting thin film is placed. Likewise, at the coil layer 12, which was already wound, the third short-circuit ring 4 made of a planer, ring-shaped, conducting thin film is placed. This procedure is repeated to place a short-circuit ring 4 made of a planer, ring-shaped, conducting thin film in every inter-layer space, that is the space between a couple of neighboring layers, until a short-circuit ring 4 of conducting thin film is placed on the last coil layer 25.

#### 【0025】

It is possible to ground the short-circuit rings 4 of conducting thin film positioned in-between every layer as well as the short-circuit rings 4 of conducting thin film positioned at top- and bottom surfaces of each coil. Grounding makes the short-circuit rings function as shield plates.

#### 【0026】

In the first embodiment of the present invention, each short-circuit ring 4 of this metallic thin film with a large surface area functions in principle in the same way as former isolation transformers of short-circuit-ring type depicted in Figure 9. Namely, through this short-circuit ring 4 of conducting thin film flows the current induced by fundamental-wave current flowing through the primary coil, its higher harmonics, and some high-frequency noise from external sources. In this case, as the high-frequency components flow essentially at the surface of the conductor only owing to the skin effect, they flow around the short-circuit ring, even if the ring is thin. Therefore, being effectively attenuated by the resistivity of the short-circuit ring 4 of conducting thin film, it is hard for the high-frequency noise to flow from the primary coil to the secondary coil. At the same time, for the resistivity of each short-circuit ring functions as a resistance commonly inserted into all of the resonance circuits, the resistivity of the short-circuit rings has the effect of dramatically reducing the amplitudes of resonances, which are distributed in the form of a number of infinitesimally small irregularly present resonance circuits due to complex combinations of capacitance and leakage inductances irregularly distributed in the coils. Meanwhile, the currents induced by the fundamental wave, which are low-frequency components, are reduced in proportion to the cross sectional area of the conducting thin film of the short-circuit ring 4. However, as the short-circuit ring is made of a thin film of thickness of  $7 \mu m$ , its cross section is small albeit its width. Therefore, the induced currents of fundamental-wave component that flow through the short-circuit ring are extremely small. As a consequence, in isolation transformers of short-circuit ring type, which are the first embodiment, the troubles caused by high-frequency noise components could be eliminated or excluded, while keeping the loss of the fundamental-wave component negligibly small.

### 【0027】

Though the number of short-circuit ring 4 of conducting thin film used in existing isolation transformers of short-circuit-ring type is one, as many as twelve short-circuit rings 4 are adopted in the first embodiment of the present invention. And these numerous short-circuit rings 4 are inserted in-between every layer that forms coils. For this reason, a tertiary coil is effectively formed adjacent to each coil layer; intensifying the electromagnetic interaction between each coil and its neighboring tertiary coil, i.e., a short-circuit ring 4 of conducting thin film. That is why the short-circuit rings 4 may eliminate or exclude the troubles caused by high-frequency noise components more effectively.

### 【0028】

Moreover, in the existing isolation transformers shown in Figure 4, in which a single short-circuit ring 4 is used, the distance from the short-circuit ring of conducting thin film to each coil layer is different, and therefore the effect due to conducting thin film of eliminating or excluding the troubles caused by high-frequency noise components does not reach all parts of a coil on the average. In contrast, in the isolation transformer of the first embodiment, in which a short-circuit ring 4 of conducting thin film is positioned tightly adjacent to every coil layer, it is possible for the effect of eliminating or excluding the troubles caused by high-frequency noise components due to conducting thin film to reach all parts of a coil on the average.

### 【0029】

For this reason, the isolation transformer of the first embodiment, in which a short-circuit ring 4 of conducting thin film is placed in each inter-coil-layer space, shows smaller amplitudes of attenuation

characteristic curve with crests and troughs of various sizes more averaged and contracted than previous ones. Consequently, in comparison with the existing isolation transformers of short-circuit-ring type with a wide short-circuit ring 4 of conducting thin film covering each surface of primary- and secondary coils or with the isolation transformers of short-circuit-ring type with a wide short-circuit ring of conducting thin film positioned between and in the vicinity of primary- and secondary coils, the isolation transformers of short-circuit-ring type in the first embodiment, have flatter characteristic curves of noise attenuation rates overall, eliminating or filtering high-frequency noise components much more effectively. In this way, the isolation transformers of short-circuit-type keep high noise-attenuation rates in the high-frequency range exceeding a few *MHz*, particularly in the range over *10MHz*, while sufficiently suppressing each amplitude of the irregular saw-tooth wave comprised by a series of crests and troughs of various sizes.

### 【0030】

It is possible to implement an isolation transformer of short-circuit-ring type, which is shown in the first embodiment with a short-circuit ring 4 distributed to each inter-coil-layer space as shown in Figure 1, modifying it in various ways as shown in Figures 3 and 4.

### 【0031】

Depicted in Figure 3 is an isolation transformer with distributing short-circuit rings 4 of conducting thin film to selected inter-coil-layer spaces instead of each one. Namely, in the primary coil 1, which is comprised by six planer, spiral, coil layers 11, 12, 13, 14, 15 and 16, a planer, short-circuit ring 4 of conducting thin film is inserted into the space between coil layers 11 and 12, 13 and 14, 15 and 16, respectively.

Likewise, in the secondary coil 2, which is comprised by six planer, spiral, coil layers 21, 22, 23, 24, 25 and 26, a short-circuit ring 4 of conducting thin film is inserted into the space between coil layers 21 and 22, 23 and 24, 25 and 26, respectively. Therefore, in the isolation transformer of short-circuit-ring type shown in Figure 3, there are in all six short-circuit rings 4 of conducting thin film used with three of them positioned in the primary coil and three others in the secondary coil.

### 【0032】

Depicted in Figure 4 is an isolation transformer to which this invention is applied with cylindrically-wound, cylindrical coil-layers instead of planer, spiral coil-layers; the cylindrical coils are multi-layer, multi-winding coils that are comprised by plural, cylindrical coil layers with their inner radii being different by the diameter of the wire. Namely, in the primary coil 1, which is comprised by five cylindrical, coil layers 11, 12, 13, 14, and 15, a cylindrical, short-circuit ring 4 of conducting thin film is inserted into each inter-coil-layer space, respectively. Furthermore, a cylindrical short-circuit ring 4 of conducting thin film is placed at the inner surface of the coil layer 11 as well as at the outer surface of the coil layer 15, respectively. Likewise, in the secondary coil 2, which is comprised by five cylindrical, coil layers 21, 22, 23, 24, and 25, a cylindrical, short-circuit ring 4 of conducting thin film is inserted into each inter-coil-layer space, respectively. Furthermore, a cylindrical short-circuit ring 4 of conducting thin film is placed at the inner surface of the coil layer 21 as well as at the outer surface of the coil layer 25, respectively. Therefore, in the isolation transformer of short-circuit-ring type shown in Figure 4, there are in all twelve cylindrical, short-circuit rings 4 of conducting thin film used with six of them positioned in the primary coil and six others in the secondary coil.

【0033】

The method to position a short-circuit ring 4 of conducting thin film into each space between coil layers in an isolation transformer of short-circuit-ring type shown in Figure 4 is as follows: Namely, at the outer surface of a bobbin (not illustrated) the first cylindrical, short-circuit ring 4 of conducting thin film is placed, and an insulated, covered copper-wire 5 is wound once cylindrically by a winding machine (not illustrated) to complete a single layer. Then at the coil layer 11, which was just wound, the second cylindrical, short-circuit ring 4 of conducting thin film is placed. Likewise, at the cylindrical coil layer 12, which was already wound, the third cylindrical, short-circuit ring 4 of conducting thin film is placed. This procedure is repeated to place a short-circuit ring 4 of conducting thin film in every inter-layer space, that is the space between a couple of neighboring layers, until the last, cylindrical, short-circuit ring 4 of conducting thin film is placed at the outer surface of the last cylindrical coil layer 25. A cylindrical, short-circuit ring 4 can be easily fabricated by winding once a conducting thin film with a specific width around a cylindrical coil layer.

【0034】

The isolation transformer of short-circuit-type shown in Figure 3, in which circular, short-circuit rings are inserted into some spaces between selected, spiral, coil-layers only, and the isolation transformers of short-circuit-type shown in Figure 4, in which a cylindrical, short-circuit ring is inserted into each space in-between a couple of neighboring, cylindrical coil-layers, have attenuation rates of high-frequency noise almost as effective as those of the isolation transformer of short-circuit-ring type shown in Figure 1. However, the

efficiency of the former transformers is somewhat less than the latter because of the smaller number of short-circuit rings used in the former transformers. Meanwhile, in comparison with the conventional isolation transformers of short-circuit-ring type or the isolation transformers of short-circuit-ring type with a wide short-circuit ring of a conducting thin film covering each surface of primary- and secondary coils, both of the isolation transformers of short-circuit-ring type shown in Figure 3 and the isolation transformers of short-circuit-ring type shown in Figure 4 have flatter overall characteristic curves of noise attenuation with each amplitude of the characteristic curves of attenuation rates averaged and contracted, eliminating or filtering high-frequency noise components much more effectively.

#### 【0035】

In this way, the isolation transformers of short-circuit-type depicted in Figures 3 and 4 keep high noise-attenuation rates in the high-frequency range exceeding a few *MHz*, particularly in the range over *10MHz*, while sufficiently suppressing each amplitude of the characteristic curve, which is an irregular saw-tooth wave comprised by a series of crests and troughs of various sizes. Moreover, the isolation transformers shown in Figure 4 has an advantage in the maneuverability in winding process over the ones shown in Figure 1.

#### 【0036】

Next, the second embodiment of the present invention will be explained. Figure 7 depicts a cross section of an isolation transformer of the short-circuit-ring type, which is the second embodiment with its bobbin and core omitted and with much reduced numbers of windings and layers for easier comprehension. Figure 8 depicts a magnified part of Figure 7. As shown in Figure 8, the insulated, covered, copper-wire 6

is fabricated with a copper-wire 6a covered with an insulated cover 6b; the insulated cover 6b is further covered with a conducting thin film 6c. The thickness of this insulated, covered, copper-wire is approximately equal to or less than the skin depth of the induced current generated by the skin effect in the high-frequency range, in which resonances should be suppressed.

#### 【0037】

This insulated, covered, copper-wire 6 is fabricated, coating metal such as aluminum by means of vacuum evaporation over a general insulated, covered, copper-wire, which has an insulated cover 6b such as enamel placed over a copper-wire 6a. In the multi-layer, multi-winding coil fabricated by winding the insulated, covered, copper-wire 6, as the surfaces of neighboring conducting thin films are tightly attached to each other, each neighboring coil layers sandwich a metallic thin film extremely tightly.

#### 【0038】

The primary coil is a ring-type coil, in which this insulated, covered, copper-wire 6 is wound with many (N1) layers and many (M1) windings. Likewise, the secondary coil 2 is also a ring-type coil, in which an insulated, covered, copper-wire 6 is wound with many (N2) layers and many (M2) windings. For example, a transformer with output 10VA for a fundamental wave with voltage 22V has 156 as M1, 166 as M2 as well as 13 as N1 and 14 as N2, respectively.

#### 【0039】

As shown in Figure 6, the core that forms a magnetic path between the primary coil 1 and the secondary coil 2, is a general one manufactured by stacking together of pieces of type E core and pieces

of type I core of specified dimensions to specified thickness after stamping them out of an isotropic silicon steel sheet of thickness of 0.5mm.

#### 【0040】

In the second embodiment of the present invention, which is comprised by the primary- and secondary coils with multi-layers and multi-windings wound by insulated, covered, copper-wires 6, conducting thin films 6c at surfaces of neighboring wires closely contact each other, most effectively sandwiching each coil-layer by the conducting thin films 6c; thus, it collectively forms an isolation transformer of short-circuit-ring type, which is at least equivalent to the one manufactured by positioning a short-circuit ring of planer, conducting, thin film to every space in-between planer, spiral, coil layers, and simultaneously by positioning a short-circuit ring of cylindrical, conducting, thin film to every space in-between cylindrical, coil layers. In other words, the isolation transformer of short-circuit-ring type in the second embodiment of this invention, which is presented in Figure 7, is equivalent at least to the combination of the two isolation transformers of short-circuit-ring type in the second embodiment depicted in Figures 1 and 4.

#### 【0041】

In this way, in the isolation transformer of the second embodiment, in which a short-circuit-ring of conducting thin film 6c is positioned closely adjacent to each other, the closely attached, neighboring, short-circuit rings of conducting thin film 6c collectively and simultaneously form planer, short-circuit rings of conducting thin film with wide surface areas inserted in-between every planer, coil layer as well as cylindrical short-circuit rings of conducting thin film

with wide surface areas inserted in-between every cylindrical coil-layer. Subsequently, as the electromagnetic couplings between each coil layer and neighboring short-circuit rings of conducting thin film become the strongest, elimination or exclusion of the troubles caused by high-frequency noise components can be performed more effectively by short-circuit rings of conducting thin film than in the first embodiment. Moreover, as it is equivalent to positioning each short-circuit ring of conducting thin film at the closest possible distance from each coil layer, in this isolation transformers of short-circuit-ring type the elimination or exclusion effects due to these equivalent short-circuit rings reach to every part of coils in a more averaged manner.

#### 【0042】

Consequently, in the second embodiment each amplitude of noise attenuation characteristic curve with a series of crests and troughs of various sizes is further averaged and contracted in comparison with the first embodiment. As a result, in comparison with the conventional isolation transformers of short-circuit-ring type with a wide short-circuit ring of conducting thin film covering each surface of primary- and secondary coils and of the conventional isolation transformers of short-circuit-ring type with a wide short-circuit ring of conducting thin film positioned between and in the close vicinity of primary- and secondary coils the isolation transformers of short-circuit-ring type in the second embodiment have larger noise-attenuation rates in the high-frequency range exceeding a few *MHz*, particularly in the range over  $10MHz$ , while sufficiently suppressing each amplitude of the irregular saw-tooth wave comprised by a series of crests and troughs of various sizes.

#### 【0043】

The first and second examples in which the present invention were implemented to isolation transformers comprised by a multi-layer, multi-winding primary coil, a multi-layer, multi-winding secondary coil, and a magnetic path of each coil have been explained in detail above. However, this invention is of course not limited to these examples of implementation. Though the short-circuit rings of conducting thin film are applied to both of the multi-layer, multi-winding primary- and secondary coils in the above examples, they may be applied to either one. Similarly, though the insulated, covered, copper-wires made by coating some copper-wires with insulated films, and further coating the insulated surfaces with conducting thin films are used in both of the multi-layer, multi-winding primary- and secondary coils in the above examples, they may be used in either one.

#### 【0044】

The configuration of the wound-up, primary- and secondary coils are not limited to circular nor rectangular ones, and coils may take any other geometry. The core that forms a magnetic path between the primary- and secondary coil is not limited to the ones manufactured by stacking together pieces of type E core and pieces of type I core shown in Figure 6, and may be a cut core or other types of cores. The isolation transformers related to the present invention may eliminate or filter high-frequency noise components even if they are used in combination with ordinary means for filtering.

#### 【0045】

##### 【EFFECTS OF THE INVENTION】

Owing to the present invention the isolation transformers of short-circuit-type with high noise attenuation rates in the high-frequency range exceeding a few *MHz*, and particularly above *10MHz*,

while sufficiently suppressing each amplitude of the irregular, saw-tooth shaped waves with a series of crests and troughs of various sizes have been provided.

Namely, the isolation transformers of short-circuit-ring type now have flatter overall characteristic curves of noise attenuation with each amplitude of the characteristic curves of attenuation rates averaged and contracted, eliminating or filtering high-frequency noise components much more effectively in the high-frequency range exceeding a few *MHz*, and particularly above *10MHz*.

Consequently, isolation transformers with extremely high reliability have been provided in comparison with the conventional isolation transformers of short-circuit-ring type with a wide short-circuit ring of conducting thin film covering each surface of primary- and secondary coils and of the conventional isolation transformers of short-circuit-ring type with a wide short-circuit ring of a conducting thin film positioned between and in the vicinity of primary- and secondary coils.

#### **[BRIEF EXPLANATION OF FIGURES]**

Figure 1 is a cross section view of the isolation transformer in the first embodiment.

Figure 2 is a cross section view of magnified part of the isolation transformer in the first embodiment shown in FIGURE 1.

Figure 3 is a cross section view of the isolation transformer of a modification in the first embodiment

Figure 4 is a cross section of the isolation transformer of another modification in the first embodiment

Figure 5 is a plan view of an example of circular, short-circuit ring of conducting thin film

Figure 6 is a oblique view of an example of the core.

Figure 7 is a cross section of the isolation transformer in the second embodiment of the present invention

Figure 8 is a cross section view of magnified part of the isolation transformer in the second embodiment shown in FIGURE 7.

Figure 9 is a cross section of an example of existing isolation transformer of short-circuit ring.

Figure 10 is a cross section of another example of conventional isolation transformer of short-circuit ring type.

Figure 11 shows a characteristic curve of attenuation rate for normal mode noise of a conventional isolation transformer of short-circuit ring type.

Figure 12 shows a characteristic curve of attenuation rate for normal mode noise of a conventional isolation transformer of electromagnetic-shield type.

#### **【EXPRANATION OF SYMBOLS】**

- 1 primary coil
- 2 secondary coil
- 3 core
- 4 short-circuit ring of conducting thin film
- 5 insulated, covered, copper-wire
- 5a copper-wire
- 5b insulated film
- 6 insulated, covered, copper-wire
- 6a copper-wire
- 6b insulated film
- 6c conducting thin film
- 11～ 16 coil layers of a primary coil
- 21 ～ 26 coil layers of a secondary coil

**【DOCUMENT】 SUMMARY**

**【SUMMARY OF THE INVENTION】**

**【THE ISSUE】**

The issue to be resolved by the present invention is to provide isolation transformers with high noise attenuation rates as well as high reliability, in the high-frequency region above a few *MHz*, by sufficiently suppressing the amplitudes of noise attenuation characteristic curves, which are irregular, saw-tooth shaped waves with crests and troughs of various sizes, of multi-layer, multi-winding transformers,

**【HOW TO RESOLVE THE ISSUE】**

An isolation transformer comprised by a multi-layer, multi-winding primary coil 1, a multi-layer, multi-winding secondary coil 2, and a core that forms a magnetic path between the aforementioned primary coil and the aforementioned secondary coil, functions as an isolation transformer to resolve the aforementioned issue by changing the coil layers of one or both of the coils formed by winding an insulated, covered, copper-wire 5 to a multi-layer, multi-winding coil, into which a number of short-circuit rings 4 made of conducting films are inserted and layered.

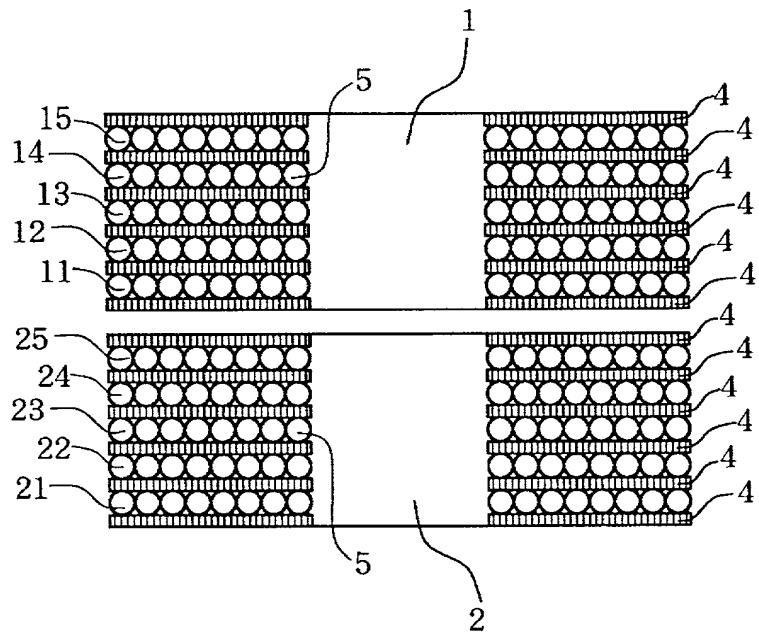
The planer configuration of the aforementioned conducting short-circuit rings 4 is made approximately identical to that of the neighboring coil-layers, and their thickness is made approximately identical to or less than the skin depth of the induced current generated by the skin effect in the high-frequency region, in which resonances should be suppressed.

**【THE DRAWING SELECTED】** Figure 1

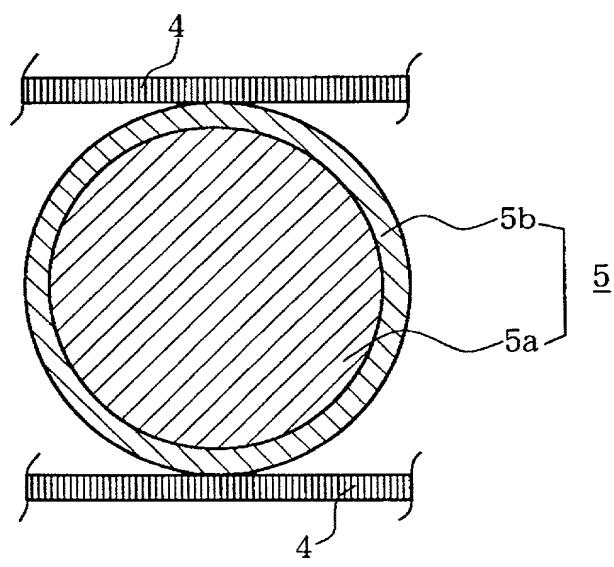
## 【DOCUMENT】

## DRAWINGS

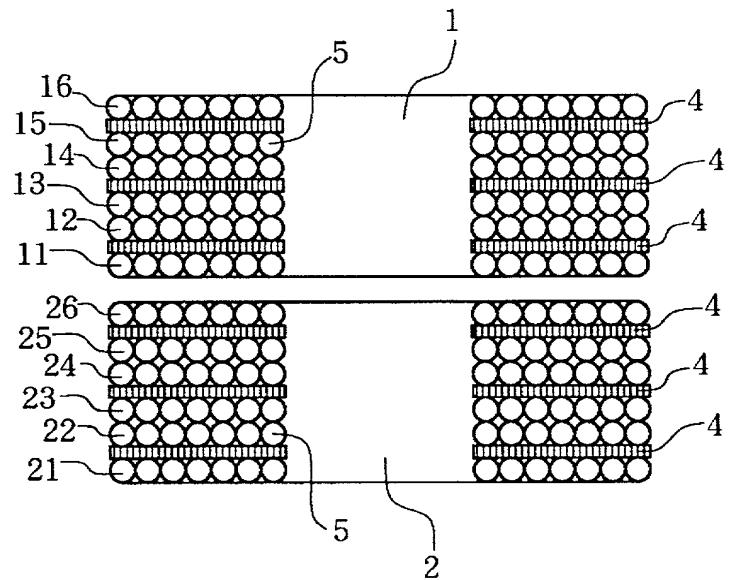
【FIG.1】



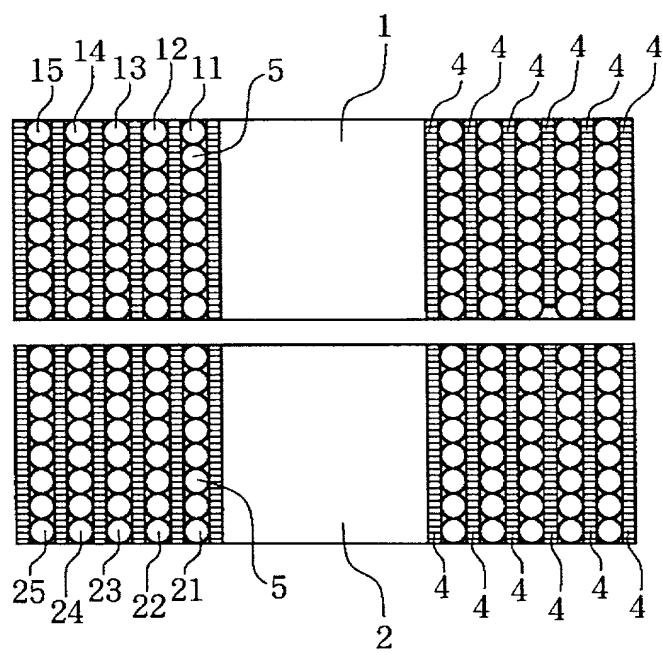
【FIG.2】



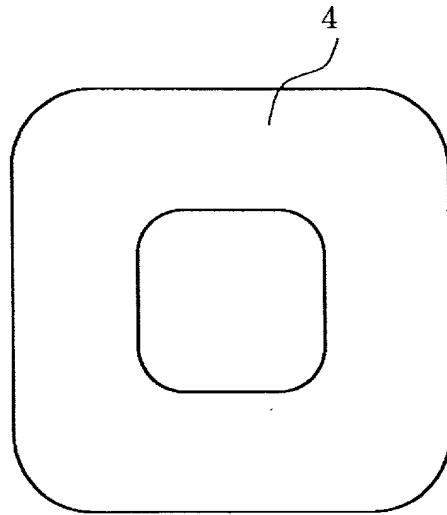
【FIG.3】



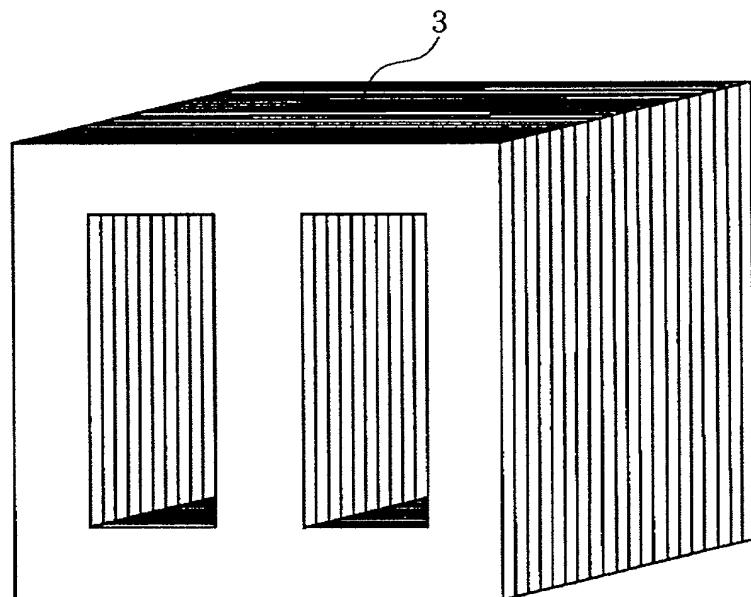
【FIG.4】



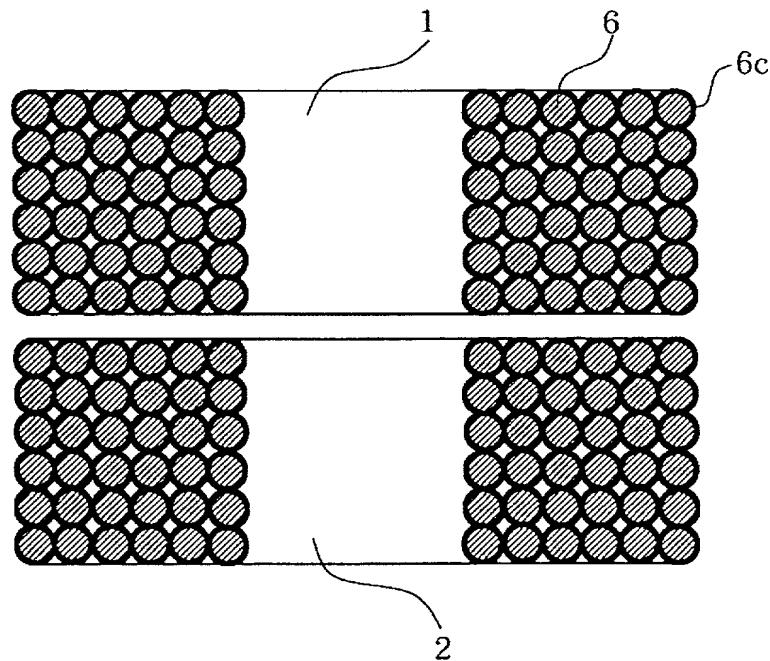
【FIG.5】



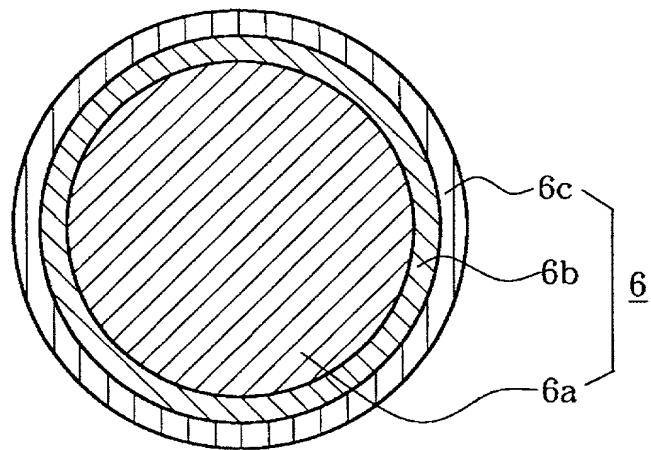
【FIG.6】



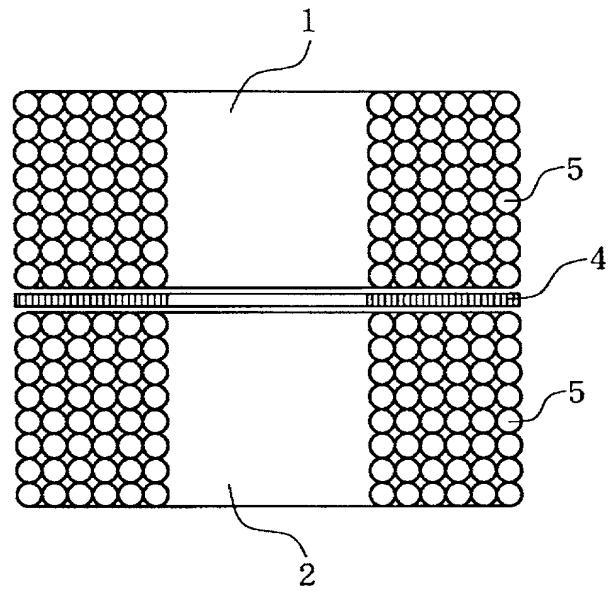
【FIG.7】



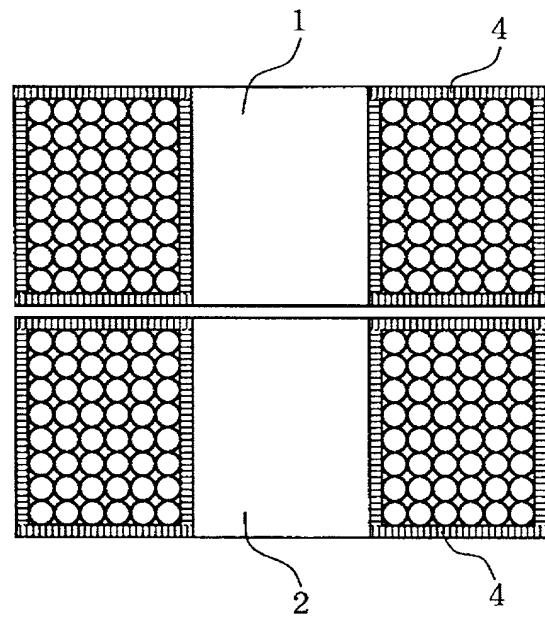
【FIG.8】



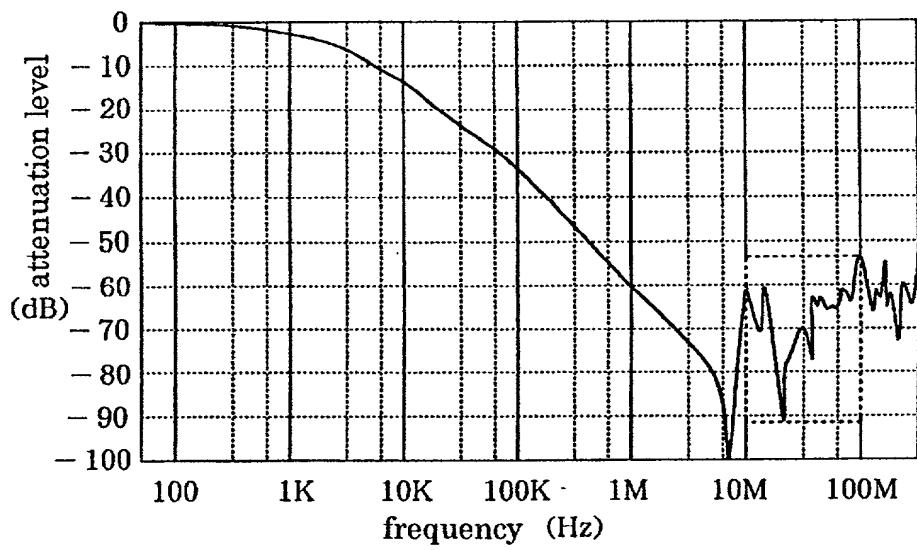
【FIG.9】



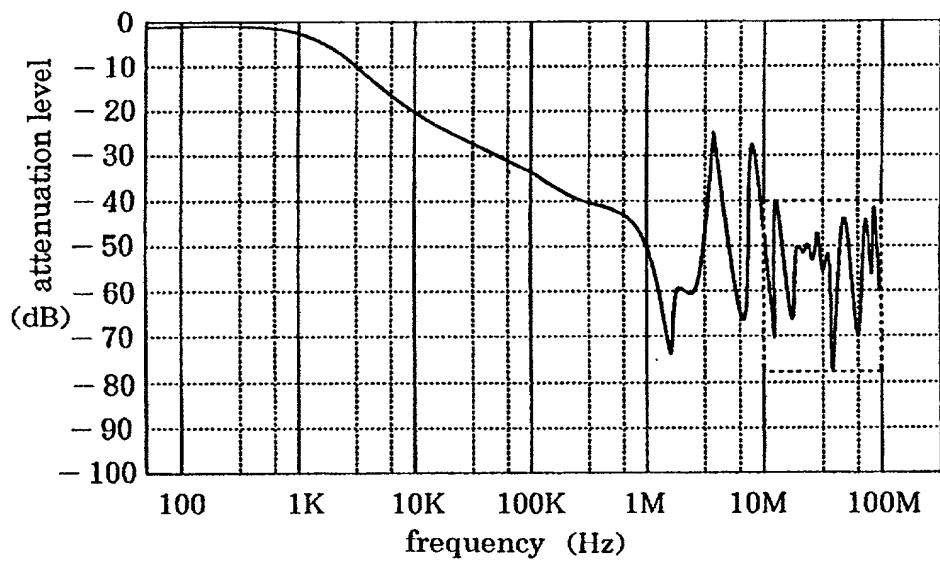
【FIG.10】



【FIG.11】



【FIG.12】



DECLARATION AND POWER OF ATTORNEY  
U.S.A.

ALL PATENTS, INCLUDING DESIGN  
For Application Based on PCT:  
Paris Convention or Non Priority

Attorneys' Docket No.

37174:164287

As a below named inventor, I declare that my residence, post office address and citizenship are stated below next to my name, that the information given herein is true, that I believe that I am the original, first and sole inventor (if only one name is listed below), or an original, first and joint inventor (if plural inventors are named below, or on additional sheets attached hereto) of the subject matter which is claimed and for which patent is sought on the invention entitled: Isolation Transformers, which is described and claimed in the attached application.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s):	Priority Claimed		
HEI11(1999)-273755 (Number)	JAPAN (Country)	28 September 1999 (Day/Mo/Year)	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below.

(Provisional Appln.Ser.No.) (Filing Date)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or any PCT international application(s) designating the United States listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application or PCT international application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Appln.Ser.No.) (Filing Date) (Status: patented, pending, abandoned)

POWER OF ATTORNEY: As a named inventor, I hereby appoint as principal attorneys Richard L. Aitken, Reg. No. 18,791; Clifton E. McCann, Reg. No. 29,565; John P. Shannon, Reg. No. 29,276; Andrew C. Aitken, Registration No. 36,729; Laurence J. Marhoefer, Reg. No. 21,091; Ralph P. Albrecht, Reg. No. 43,466 and Cameron H. Tousi, Reg. No. 43,197, to prosecute and transact all business in the Patent and Trademark Office connected with this application and any related United States and international applications. Please direct all communications to:

LANE, AITKEN & McCANN  
Watergate Office Building  
2600 Virginia Avenue, N.W., Suite 901  
Washington, D.C. 20037  
Telephone: (202) 337-5556  
Facsimile: (202) 337-8073

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code; and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Full name and signature of sole or first inventor: Akihiko Yagasaki 23 May 2000  
Name: Akihiko YAGASAKI Date

Residence: Tokyo, Japan

Country of Citizenship: Japan

Post Office Address: Denkenseiki Re. In. Corp., 1-41-21,  
Hachiman-cho, Higashi-kurume city, Tokyo, Japan

Full name and signature of second inventor:

Name: Date

Residence:

Country of Citizenship:

Post Office Address:

Full name and signature of third inventor:

Name: Date

Residence:

Country of Citizenship:

Post Office Address:

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Akihiko YAGASAKI

Serial No. to be assigned

Filed: concurrently herewith

For: ISOLATION TRANSFORMERS

**NOTICE OF CHANGE OF DESIGNATED ADDRESS**

Assistant Commissioner for Patents  
Washington, D.C. 20037

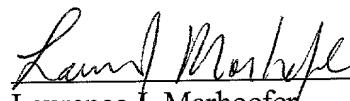
Sir:

To the extent the following is not already of record in the file of the above-identified application, please note changes in the firm name and mailing address, and telephone and telefax numbers of all counsel of record in the file:

VENABLE  
Post Office Box 34385  
Washington, D.C. 20043-9998

Telephone: (202) 962-4800  
Telefax : (202) 962-8300

Respectfully submitted,

  
\_\_\_\_\_  
Laurence J. Marhoefer  
Registration No. 21,091

Dated:  
DC2DOCS1/222204